BRITISH STANDARD

BS EN
13687-3:2002

Products and systems for the protection and repair of concrete structures — Test methods — Determination of thermal compatibility —

Part 3: Thermal cycling without de-icing salt imact

The European Standard EN 13687-3:2002 has the status of a British Standard

ICS 91.080.40

BSI
British Standards

National foreword

This British Standard is the official English language version of EN 13687-3:2002.

The UK participation in its preparation was entrusted by Technical Committee B/517, Concrete, to Subcommittee B/517/8, Protection and repair of concrete structures, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

Cross-references

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This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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This British Standard, having been prepared under the direction of the Building and Civil Engineering Sector Policy and Strategy Committee, was published under the authority of the Standards Policy and Strategy Committee on 19 September 2002

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English version

Products and systems for the protection and repair of concrete structures - Test methods - Determination of thermal compatibility - Part 3: Thermal cycling without de-icing salt impact

Produits et systèmes pour la protection et la réparation des structures en béton - Méthodes d'essai - Détermination de la compatibilité thermique - Partie 3: Cycles thermiques sans immersion dans des sels déglaçants

Produkte und Systeme für den Schutz und die Instandsetzung von Betontragwerken - Prüfverfahren - Bestimmung der Temperaturwechselverträglichkeit - Teil 3: Temperaturwechselbeanspruchung ohne Tausalzangriff

This European Standard was approved by CEN on 23 December 2001.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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EUROPÄISCHES KOMITEE FÜR NORMUNG

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Contents

Foreword

This document EN 13687-3:2002 has been prepared by Technical Committee CEN/TC 104 "Concrete and related products", the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by August 2002, and conflicting national standards shall be withdrawn at the latest by December 2002.

It has been prepared by sub-committee 8 "Products and systems for the protection and repair of concrete structures", the secretariat of which is held by AFNOR.

This Part of this European Standard describes a method of test for determining the thermal compatibility of surface protection systems when applied to a standard concrete, by thermal cycling between 60 °C and -15 °C, including immersion in water but without immersion in de-icing salt solution. It is one of a series of inter-related parts dealing with the thermal compatibility of repair products and systems. The other parts of this standard are:

EN 13687-1, *Products and systems for the protection and repair of concrete structures - Test methods - Determination of thermal compatibility - Part 1: Freeze-thaw cycling with de-icing salt immersion*.

EN 13687-2, *Products and systems for the protection and repair of concrete structures - Test methods - Determination of thermal compatibility - Part 2: Thunder-shower cycling (thermal shock).*

EN 13687-4, *Products and systems for the protection and repair of concrete structures - Test methods - Determination of thermal compatibility - Part 4: Dry thermal cycling.*

EN 13687-5, *Products and systems for the protection and repair of concrete structures - Test methods - Determination of thermal compatibility - Part 5: Resistance to temperature shock.*

Annex A is normative.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

This standard is the third in a series of five parts to assess the thermal compatibility of repair products and systems, comprising grouts, mortars and concretes and surface protection systems, used for the repair and protection of concrete structures. The method specified in this Part measures the effect of thermal cycling, including wetting and drying but without de-icing salt immersion, upon surface protection and injection systems used as part of a repair product or system.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text, and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 196-1, *Methods of testing cement – Part 1: Determination of strength.*

EN 1504-1, *Products and systems for the protection and repair of concrete structures - Definitions, requirements, quality control and evaluation of conformity - Part 1: Definitions.*

prEN 1504-2, *Products and systems for the protection and repair of concrete structures - Definitions, requirements, quality control and evaluation of conformity - Part 2: Surface protection systems.*

EN 1542, *Products and systems for the protection and repair of concrete structures - Test methods - Measurement of bond strength by pull-off.*

EN 1766, *Products and systems for the protection and repair of concrete structures - Test methods - Reference concretes for testing.*

3 Terms and definitions

For the purposes of this European Standard, the terms and definitions given in EN 1504-1 apply.

4 Principle

The surface protection system is applied to a reference concrete test specimen prepared according to EN 1766. After curing of the surface protection system, the test specimen is subjected to freeze-thaw cycling with water immersion between (60 ± 2) °C and (-15 ± 2) °C, but excluding immersion in saturated de-icing salt solution. Following the temperature cycling, visible defects are recorded and the adhesion of the surface protection system to the concrete substrate is determined by pull-off test (according to EN 1542). Thermal cycling is carried out either continuously in a programmable climatic chamber or manually using a cooler, a water bath and an oven.

5 Apparatus

5.1 Laboratory, maintained at the standard laboratory climate of (21 ± 2) °C and (60 ± 10) % RH (see annex A).

5.2 Mixer, for mixing the constituents of the mortar. Unless stated otherwise by the manufacturer, use a forced action pan mixer.

5.3 Concrete test specimens, of dimensions of 300 mm x 300 mm x 100 mm to EN 1766 and type as specified in prEN 1504-2.

5.4 Core drilling machine with a diamond tool, internal diameter 50 mm as specified in EN 1542.

5.5 Pull off equipment, for measuring the pull-off strength according to EN 1542.

5.6 Climatic cabinets, comprising a dry air cooler at (-15 ± 2) °C, a water bath at (21 ± 2) °C and an oven at (60 ± 2) °C. This equipment is used as the reference method.

5.7 Programmable climatic cabinet, comprising an enclosed, insulated cabinet with heating, cooling and flooding equipment capable of maintaining temperatures of between (60 ± 2) °C and (-15 ± 2) °C. Adequate air and water motion for a homogenous temperature distribution in the cabinet shall be ensured. Inside shall be a temperature sensor to measure and record the temperature near the samples. The programmable climatic cabinet shall have a controller for the heating, cooling, flooding and emptying cycles.

5.8 Thermosetting resin for sealing the sides of the concrete test specimens to prevent penetration of water into the concrete.

6 Preparation of test specimens

Three concrete test specimens (see 5.3) are required for each test, with one serving as a reference specimen. Prior to application of the surface protection system, all materials shall be stored in the standard laboratory climate (see 5.1) for at least 24 h. The surface protection system shall be applied to the concrete test specimens in accordance with manufacturers instructions at the standard laboratory climate (see 5.1) or such alternative environments as may be specified for the intended use.

After application of the surface protection system, the samples shall be cured in accordance with the requirements of annex A.

Before starting the test, all surfaces of the specimens except the 300 mm x 300 mm test face shall be coated with thermosetting resin (see 5.8) to prevent penetration of liquid into the side and rear of the concrete test specimen during the test, allowing full cure of the resin in accordance with the requirements for PC given in annex A.

7 Procedure

After completing the preparation, thermal cycling shall then be carried out by one of the following methods :

a) manual cycling using the cooler, water bath and oven (see 5.6), which is the reference method ;

b) in a programmable climatic cabinet (see 5.7).

Two of the prepared concrete test specimens are used for the thermal cycling, with the third specimen kept in the standard laboratory climate (see 5.1) for the duration of the test as a control.

7.1 Thermal cycling - reference method

Thermal cycling takes place by manual transfer of the test specimens between the climatic cabinets (see 5.6). In each of the climatic cabinets the slabs are positioned upright, with a distance of at least 100 mm between the slabs and of at least 50 mm from the slabs to the walls.

The test specimens shall be subjected to the following test cycle, with one cycle lasting for 24 h :

— 2 h water storage at (21 ± 2) °C ;

— 4 h storage in air at (-15 ± 2) °C ;

— 2 h water storage at (21 ± 2) °C ;

— 16 h storage in air at (60 ± 2) °C.

During an interruption of the cycle storage, such as weekends, the test specimens shall be stored in the standard laboratory climate (see 4.1).

After every ten cycles, the positions of the test specimens in the storage tanks should be changed on a rotation basis, to compensate for any slight differences in temperature that might occur.

The complete 24 h cycle shall be repeated for the number of cycles specified in prEN 1504-2.

7.2 Thermal cycling - Programmable climatic cabinet

Automation of the reference procedure (see 7.1) can be achieved by use of a programmable climatic cabinet (see 5.7), following the temperature profile shown in Figure 1.

The coated concrete test specimens are positioned upright, with a distance of a least 100 mm maintained between the slabs and of at least 50 mm from the slabs to the cabinet walls.

One cycle lasts for 24 h and comprises the following stages :

— 2 h water storage at (21 ± 2) °C (including final emptying within a maximum of 15 min) ;

— 3 h cooling with air at (-15 ± 2) °C (the maximum permissible deviation from the linear temperature curve between 21 °C and -15 °C shall be 3 °C) ;

— 4 h storage at (-15 ± 2) °C ;

— 15 min heating with water at (21 ± 2) °C (flooding within a maximum of 15 min) ;

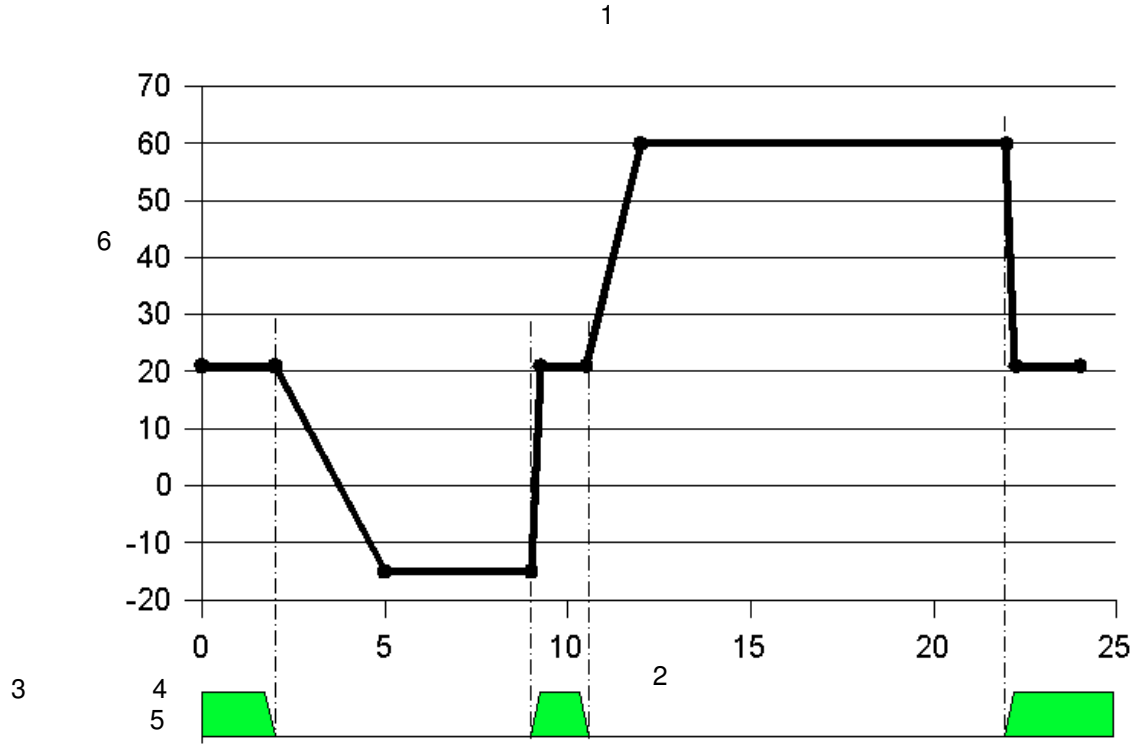
— 1 h 15 min water storage at (21 ± 2) °C (including final emptying within a maximum of 15 min) ;

— 1 h 30 min heating with air at (60 ± 2) °C (permissible deviation from linear temperature curve between 21 °C and 60 °C shall be ± 3 °C) ;

— 10 h air storage at (60 ± 2) °C ;

— 15 min cooling with water at (21 ± 2) °C (flooding within a maximum of 15 min) ;

— 1 h 45 min water storage at (21 ± 2) °C.



Key

1 Computer-controlled 24 h cycle
2 Time (h)
3 Flooding cycle
4 Full
5 Empty
6 Temperature (deg °C)

Figure 1 — Thermal cycling between (-15 ± 2) °C and (60 ± 2) °C

After every ten cycles, the positions of the test specimens in the cabinet should be changed on a rotation basis, to compensate for any slight differences in temperature that might occur.

The complete 24 h cycle shall be repeated for the duration specified in prEN 1504-2.

8 Evaluation of results

Every ten cycles, the test specimens shall be visually inspected for surface alterations (cracks, peeling, blistering, delamination, bubbling or other surface defects).

Cracks > 0,05 mm and any observed surface alterations shall be reported. The final visual inspection should be performed at least 16 h after the end of the cycling.

The pull-off strength of the surface protection system applied to the control specimen and the test specimens shall be determined according to EN 1542 after conditioning at the standard laboratory climate for not less than seven days after completion of cycling.

9 Test report

The test report shall include the following information :

a) a reference to this European Standard, including the number, title and date of issue ;

b) name and address of the test laboratory ;

c) identification number and date of the test report ;

d) name and address of the manufacturer or supplier of the product(s) ;

e) name and identification marks or batch number(s) of the product(s) ;

f) date of supply of the product(s) ;

g) date of preparation of the test specimens ;

h) conditions of storage of prepared specimens prior to test ;

i) date of test and details of test equipment used including the make, type and capacity and calibration details or identification number of the apparatus ;

j) the total number of cycles carried out ;

k) the results (single values, mean values and standard deviations) of the pull off test including individual forms of fracture, and any observed surface alterations after removal from the test cabinet ;

l) the type and dimension of the concrete test specimens according to EN 1766 ;

m) a description of the surface protection system under test and whether it is a single or multi layer system ;

n) precision data ;

o) date of test report and signature.

Annex A
(normative)

Summary of temperatures and humidities for the curing, conditioning and testing of repair products and systems

A.1 Curing

A.1.1 CC (grouts, mortars and concretes)

- Prepare as EN 196-1, cover in film for 24 h ;
- demould after 24 h ;
- cure under water at (21 ± 2) °C for 27 days.

A.1.2 PCC (grouts, mortars and concretes)

- Prepare as EN 196, cover in film for 24 h ;
- demould after 24 h and wrap in film for 48 h ;
- unwrap and cure for 25 days in a standard laboratory climate of (21 ± 2) °C and (60 ± 10) % RH.

A.1.3 PC (grouts, mortars and concretes) and surface protection systems

- Cure for 7 days at (21 ± 2) °C and (60 ± 10) % RH.

A.2 Conditioning and testing

For specific applications, the following definitions apply :

A.2.1 Standard laboratory climate (Dry conditioning)

- Take from the curing/storage environment and condition for 7 days in a standard laboratory climate of (21 ± 2) °C and (60 ± 10) % RH.

A.2.2 Wet conditioning

- Immerse for 7 days at (21 ± 2) °C, or for CC take directly for test after 28 days of immersion ;
- remove all surface water by standing upright for 30 min before using for tests.

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